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Research article

# Assessment of barriers and drivers for implementation of blue-green solutions in Swedish municipalities

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ABSTRACT

Due to increased urbanisation, and climate change, there have been calls for a more sustainable management of stormwater. Blue-green measures have been recognised as a sustainable solution and a necessary complement to pipe-bound approaches. The aim of this study is to identify barriers and drivers in the implementation of blue-green measures in a Swedish context, to increase the understanding of how they could be implemented in a more successful manner. The study is qualitative and based on semi-structured interviews. Through the lens of transition theory, barriers and drivers for blue-green measures were identified and they give an updated picture of Swedish urban stormwater management. Many factors encourage municipal actors to implement blue-green solutions, such as increased need for recreation, protection of biodiversity and climate change. Identified barriers are found within the municipal stormwater management it-self, but can also be found outside the storm water management structure, such as lack of knowledge among politicians, officials, exploiters and civilians, fragmented roles and responsibilities in general, as well as uncertainty of the effects and cost of new alternatives. The study has three main findings; Several barriers were mentioned by most of the interviewees clearly show that a wide range of changes are needed to alter the current stormwater management regime; Niche innovations are often put forward as a way to enhance socio-technical transition, but this study is that such an approach is over-simplified instead elaborated suggestions for an alteration of urban stormwater management is given, both with top-down and bottom-up perspective. For the success of blue-green solutions, educational efforts are important at different levels in the planning, building and maintenance process of blue-green solutions. Therefore, employees must have a good general knowledge of both blue and green issues as well as having contacts in the different sectors of the municipality. To conclude we argue that a transition can not only be induced by pilot projects but requires change in legal structures as well as altered financing models for blue-green solutions. Moreover, the ongoing, but slow, change should therefor probably be interpreted as a shift to a new regime, but rather an evolutionary transition where new approaches are combined with traditional, pipe-bound solutions.

## 1. Introduction

More and more people choose to live in cities, which leads to increased urban growth (Jha et al., 2012). This results in major land use changes, which has a complex set of economic, social and environmental impact on the urban space. It is difficult to predict the complete consequences of this growth, as it the process is influenced by both the type and the speed of growth. Simultaneously, climate change leads to increased torrential rains, flood risk, heat waves, drought, and sea level rise (Maksimović et al., 2015), which will increase the demand on stormwater management and drinking water provision to the growing urban areas (Wong and Brown, 2008; Bates et al., 2008; Loftus et al., 2011).

Despite growing urban areas, due to a history of relative sparse residential construction compared to other countries Sweden has a housing shortage (Swedish National Board of Housing, Building and Planning, 2016). This shortage combined with political ambitions to reduce emission of greenhouse gases and spare agricultural land drive a development of a denser urban space rather than urban sprawl and putts a high pressure on urban space management.

Due to these challenges it is argued that new approaches to urban stormwater management is urgently needed in Sweden (SOU, 2014:50). Stormwater management must be able to maintain its functionality during sudden local extreme events and simultaneously provide benefits for people and nature in denser urban contexts (Ashley et al., 2011). This necessitates a holistic planning, minimising environmental impact,

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utilise land in a more multifunctional way and takes social and well-being aspects into consideration while being efficient with economic resources (Stahre, 2004; Cettner et al., 2013). This ambition has in Sweden and many other countries been met with the idea that technical urban stormwater solutions should be combined with solutions using nature's diversity as inspiration. One way is to see the urban green infrastructure as a part of the urban water management, structure including features such as green roofs, rain gardens and rainwater ponds (Voskamp & van de Ven, 2015; Maksimović et al., 2015, 3). The dynamic between water and vegetation can create an environment that can buffer and balance extreme weather events such as torrential rain and flooding (Dreiseitl, 2015), make them more resilience to climate change (Semadeni-Davies et al., 2008) cost-efficient (Ossa-Moreno et al., 2017) and therefore increase and accelerate the desired transformation of urban water management (Mguni et al., 2015).

Blue-green solutions are frequently promoted as umbrella terms for such sustainable multifunctional measures able to reduce negative effects of urbanisation and adapt to a changing climate, such as heat and water regulation, air and water purification, increased biodiversity and recreation (Swedish National Board of Housing, Building and Planning, 2010a, Cettner et al., 2014, Voskamp & van de Ven, 2015, Lerer et al., 2015, European Commission, 2015). Other terms that are used are nature-based solutions (NBS), sustainable urban drainage systems (SUDS), water sensitive urban design (WSUD), low impact development (LID), and sponge city (see Fletcher et al., 2015; Jia et al., 2016). These concepts have slightly different flavours from a more green to more blue focus and usually have a stronger affiliation to one scientific discipline than another. Implemented in the urban context their aim is typically stormwater detention, infiltration and purification in a decentralised manner.

In Sweden, blue-green solutions are, as stormwater solutions, known since the 1970s, primarily under the name *lokalt omhändertagande av dagvatten* (LOD, local treatment of stormwater) or *öppen dagvattenhantering* (open stormwater management). In the last decade there is an emerging trend where municipalities support blue-green solutions to handle urban social challenges as well as effects of climate change (Ashley et al., 2011; Cettner et al., 2014). However, the dominating solution to stormwater management employed by municipalities, developers and contractors, is still pipe-bound (Cettner et al., 2012; Ashley et al., 2011).

Municipalities are legally responsible for the stormwater management in Sweden, a responsibility frequently delegated to public water utilities. A municipality can direct a certain stormwater management approach on private land as a part of the building permission process but have little influence on already built areas. Water issues have gained an increasingly larger place in the physical planning (Swedish National Board of Housing, Building and Planning, 2010a). However, within the current stormwater management regime, water utility companies are not allowed to spend money collected for urban drainage on solutions that cannot directly be motivated to be a part of a structure for urban drainage in accordance with municipal responsibility (SWWA, 2016). This means that reconstruction of a park to handle stormwater during extreme precipitation events have be difficult to motivate legally, as stormwater control during extreme events are not the responsibility of Swedish municipalities. In addition, there is EU legislation implemented in Sweden, which potentially could influence the regime of stormwater management: the EU Water Framework Directive (WFD) (Directive, 2000/60/EC) and the Floods Directive (FD) (Directive, 2007/60/EC). The WFD aims to ensure access to water of good quality in river basins and the FD handles flood risk management, however floods from sewers may be excluded.

During the two recent decades, numerous pilot projects and experiments with different types of blue-green solutions have been implemented, both in Malmö (Villarreal et al., 2004; Stahre, 2008, Haghighatafshar et al., 2018; Sörensen & Emilsson n.d.) and Helsingborg (Hassby and Björling, 2015), the case municipalities in this article. Several of them are even well known in the growing literature of blue-green solutions or increasingly mentioned under the name of nature-based solutions (NBS) (Keesstra et al., 2018). However, these projects have often been financed by external money in the form of various EU projects and as such been seen as a way to gain practical knowledge alternatives measures for stormwater management (Farrelly and Brown, 2011). Some of them are included in new built areas, but frequently not as much as the initial ambition. They are not yet part of the everyday development of urban areas in Sweden. A question that we ask in this paper: Why are these solutions not being implemented at a faster rate and not spread beyond the externally financed projects? Several studies have noted that the uptake of blue-green solutions is slow (van de Meene et al., 2011; Brown et al., 2009a). Cettner et al. (2012) describe this slow transformation of stormwater management in Sweden as caused by the “pipe-bound culture”.

The aim of this paper is to identify barriers and drivers hindering or encouraging the transition from a pipe-bound stormwater management to a widespread implementation of blue-green solutions to handle urban stormwater. Thereafter based on transition theory we discuss these results and suggest potential ways to overcome these barriers to encourage transition to a more sustainable and multifunctional urban stormwater management system.

The article is structured as follows: First follows the theoretical basis of the study, then the research method is described. After this, the empirical material, i.e. the categorised drivers and barriers and examples from the interviews, are presented. The final section consists of a discussion of the empirical material in relation to transition theory and findings of other studies as well as suggestions on how to handle identified barriers.

## 2. Transition theory – an analytical tool to assess socio-technical change

To explore barriers and drivers that may exist in relation to an altered management of stormwater in Sweden we use transition theory. Transition theory sees socio-technical *systems*, as composed of three constellations: *regime, niche* and *niche-regime*. Surrounding these is the *landscape* forming the pre-requisites for the system (de Haan and Rotmans, 2011). The three constellations and their surrounding landscape is shown in Fig. 1. While Rotmans et al. (2001) relate the levels to bureaucratic levels (macro, meso, and micro level) or nested hierarchies, we perceive the levels as including organisational, technical as well as social systems as suggested by Geels (2011). In the following section we briefly explain the features of the different levels and thereafter we discuss how transition theory explain change.

The *regime* is the most powerful constellation of the system and is the dominating way that societal needs are met (de Haan and Rotmans, 2011). A regime includes institutions, technologies, practical applications and social relationships (Geels, 2002; Smith et al., 2005). In

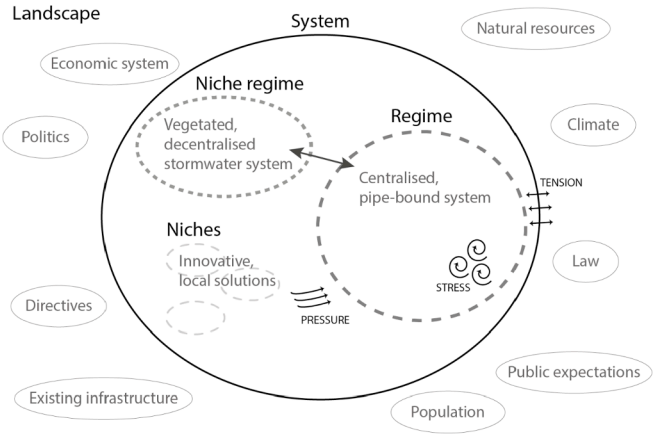


**Fig. 1.** Multi-level perspective of socio-technical system with three constellations: regime, niche and niche-regime. The landscape forms the pre-requisite for the system. Pressure, stress and tension are possible drivers for transition. Adopted from Ashley et al. (2011) and de Haan and Rotmans (2011).

Sweden, the current urban stormwater management regime consists of a pipe-bound system with a centralised management. Several actors are involved in developing and maintaining it (Cettner et al., 2012). According to Transition theory a new regime is more than just an evolutionary transformation of a previous one. For instance, to change from combined to separate sewers is an evolutionary transformation, while the change from pre-sewered cities to sewered cities can be considered as a transition to a new regime (Ashley et al., 2011).

A *niche* consists of solutions that only meets certain, specific societal needs (de Haan and Rotmans, 2011). The niche level is mainly referred to where emerging innovations are developed that are fundamentally different from existing solutions at the regime level (Geels, 2011) for example stormwater barrels for private gardens or pilot projects that use elements of blue-green solutions.

A *niche-regimes* is a regime that is not currently dominating, while it has significant power to compete with the regime for the functioning of the system (de Haan and Rotmans, 2011). While not yet implemented on larger scale, a niche-regime is somewhere between niches and the regime in strength.

The *landscape* level represents the wider context (legal systems, demography, economy and the natural environment) that in a long-term perspective is able to influence and affect the development of the practices at regime, niche-regime and niche levels (Geels, 2002; Geels, 2011; Koppenjan et al., 2012). In the case of stormwater management, climate, legislation and politics could exemplify processes or states on landscape level.

*Drivers* that are able to induce such as socio-technical transition has been divided into three categories: stress, pressure and tensions (de Haan and Rotmans, 2011). *Pressure* comes from alternative technologies that become viable competitors to the regime. *Stress* emerges when the regime is inadequate or internally inconsistent in meeting the needs of the system. *Tension* is when the system compromises in its relation to its natural or social environment. The tensions can either be structural, related to physical aspects of the regime, legal or cultural, related to cognitive or discursive aspects of the regime (de Haan and Rotmans, 2011). Structural tensions are more frequently related to the landscape level where as the cultural tensions can emerge from both niche and landscape level (Ashley et al., 2011).

A central idea of transition theory scholars has been that the drivers for change emerges from niche through alternative solutions to niche-regime to displaced or replaced regime. From this perspective the challenge of the regime emerges from the dispersal of new social norms concerning how to solve a problem, know-how and motivation that alternative solutions bring with them when developed and implemented at the niche level (van der Brugge et al., 2005; de Haan and Rotmans, 2011; Ashley et al., 2011; Farrelly and Brown, 2011). It has also been argued that drivers to alter a regime can also emerge from landscape level (Koppenjan et al., 2012; Geels, 2011 Smith et al., 2005).

Even though transition theory to a large extent has focused on drivers to change, barriers to change has also been in focus, due to entrenched, technological path dependency and cognitive lock-ins, it is (Brown and Farrelly, 2009a; Werbeloff and Brown, 2011). Such implementation *barriers* have different origins and can be technological, legal, organisational, financial, social, educational, or related to political will (Holtz et al., 2008; Brown and Farrelly, 2009a; Brown and Farrelly, 2009b; van de Meene et al., 2011; Cettner et al., 2013; Cettner et al., 2014; Winz et al., 2014; Mguni et al., 2015). Sometimes barriers have been referred to as regulative, normative and cognitive aspects of a regime (Scott, 1995).

The perspective we take in this paper is that barrier and drivers can originate from one part of the system but affect the outcome in another part and transition efforts usually has to target different aspects of the regime to induce change (Scott, 1995; Geels, 2002) and transformation of a regime is complex and consist of both physical, administrative and structural changes in the regime (Bettini et al., 2015).

## 3. Method

The empirical material was collected through interviews with municipal and water utility company officials in two municipalities and two water utility companies in the south west of Sweden. The two municipalities (Malmö and Helsingborg) included in this study, use two different water utility companies, VA Syd (Malmö) and NSVA (Helsingborg), to provide stormwater management and water treatment services to a total of 730,000 persons (Fig. 2). Malmö (330,000 inhabitants) and Helsingborg (140,000 inhabitants), are the two largest municipalities in the region and have a long experience of working with blue-green solutions.

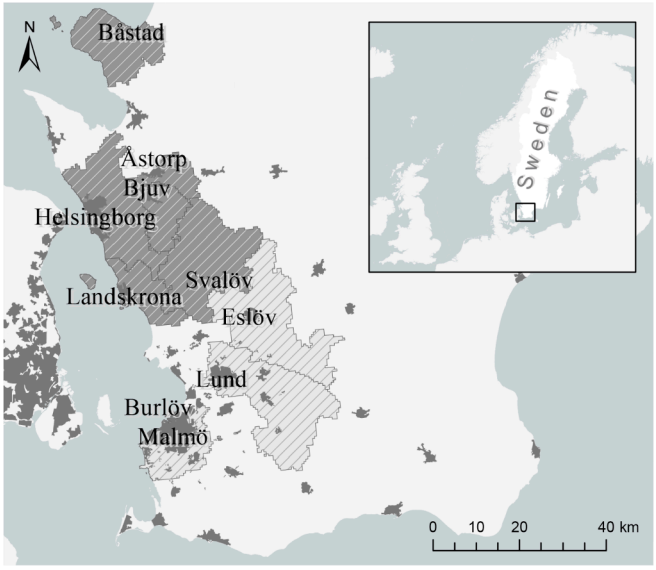


**Fig. 2.** Municipalities covered by the water utility companies in the study, NSVA (dark grey) and VA Syd (light grey).

Interviewees were chosen by contacting a key actor in the municipalities, and new interviewees were chosen by snowball sampling, aiming to cover a broad range of expertise on management of stormwater and blue-green solutions (Flowerdew & Martin, 2005). The interviewees worked at different departments, such as environmental administration and planning office, and have a varied academic background. A majority have a background in natural and technical science. To show their general work area in the municipality we categorised the interviewees in the three categories *blue*, *green* or *planning*, showing whether they work primarily with stormwater management, ecology and urban green, or planning and architecture respectively. The interviews were recorded, transcribed and written down in text format (Table 1). In total, 20 persons were interviewed.

The purpose of the interviews was to collect information about barriers and drivers related to the implementation of alternative solutions of urban stormwater management. The interviews were semi-structured (Flowerdew & Martin, 2005) and based on a simple interview guide covering three general themes: the respective 1) barriers and 2) drivers related to implementation of blue-green solutions and 3) what would be needed to overcome the barriers. The initial question was always general and based on the general theme, thereafter 1–3 follow up questions were asked, such as what do you mean? Could you give examples? Do you have more examples? Is it a barrier/possibilities/need in other sectors of the municipality?

14 interviews were conducted in the office of the interviewee and 6 interviews were performed over the telephone. The interview lasted for about 40 min, depending on the experience and working field of the interviewee.

The material was analysed through the hermeneutic process – a circular analysis process where new insights are integrated from the understanding and interpretation of the studied material through a constant exchange between the parts and the whole (Kvale and Brinkmann, 2009). Based on this analysis, drivers and barriers were identified and compiled in a data table to categorise the informants' quotes and expressions. This approach to categorise the empirical

**Table 1**
Interviewees and their professional background.

| No | Municipality | Category | Professional title or role |
|---|---|---|---|
| 1 | Helsingborg | Green | Environmental strategist |
| 2 | Helsingborg | Green | Head of department, environmental strategy |
| 3 | Helsingborg | Planning | Water planner |
| 4 | Helsingborg | Planning | Landscape architect |
| 5 | Helsingborg | Planning | Physical planner (zoning) |
| 6 | Helsingborg | Planning | Plan co-ordinator (zoning) |
| 7 | Helsingborg | Planning | Landscape engineer |
| 8 | Helsingborg | Planning | Head of department, building permits |
| 9 | Malmö | Planning | Community planner |
| 10 | Malmö | Planning | Landscape architect |
| 11 | Malmö | Green | Project leader (leads projects and development) |
| 12 | Malmö | Green | Project leader (leads projects and responds to referrals) |
| 13 | Malmö | Planning | Building permits, architect |
| 14 | Malmö | Planning | Head of department, planning |
| 15 | Malmö | Planning | Physical planner |
| 16 | Malmö | Planning | Environmental strategist |
| 17 | Malmö | Planning | Environmental administrator |
| 18 | NSVA | Blue | Civil engineer |
| 19 | NSVA | Blue | Civil engineer |
| 20 | VA SYD | Blue | Head of department, new construction and exploration |

material gave a clear structure and stability regarding which actor that express which drivers and barriers. In practice this meant that the articles authors together agreed on a consistent interpretation of the statement of drivers and barriers from the interviewees. From the developed categorisation, patterns were distinguished as to which drivers and barriers that were mentioned by the interviewees. Analysing and categorising of the empirical material was made in two steps. Step one was to count how many of the interviewees mention a specific driver or barrier. This is reported in Tables 2 and 3 in the result section of the article. In the second step, drivers and barriers were discussed in relation to the transition theory. Finally, suggestions for changes in the stormwater management were developed. No categorisation is perfect, meaning that we use them as a way to simplify and categorise the answers of the respondents to be able to give a general picture. Some of the categories are related to both a barrier and a driver, such as economy and knowledge.

## 4. Results

In this section, the result from the interviews and an analysis of identified barriers and drivers for the implementation of alternative stormwater structured is made.

### 4.1. Drivers for blue-green solutions

Five types of drivers were identified: ecosystem services, climate change, economy, politics of urban densification, and knowledge of new municipal employees. In Table 2, these drivers are presented in relation to how many of the informants that mentioned them. Some of the drivers are also seen as barriers (see section 4.2)

**Table 2**
Drivers for increased implementation of blue-green solutions identified among the informants. The categories are a categorisation where *blue* is officials working mainly with water, *green* is officials working mainly with ecology and vegetation and *planning* is officials working mainly with urban planning or architecture.

| Driver | Number of informants mentioning it | Green | Blue | Planning |
|---|---|---|---|---|
| Ecosystem services | 20/20 | 4/4 | 3/3 | 13/13 |
| Climate change | 16/20 | 4/4 | 2/3 | 10/13 |
| Economy | 7/20 | 1/4 | 1/3 | 5/13 |
| Politics of urban densification | 7/20 | 2/4 | 0/3 | 5/13 |
| Knowledge of new municipal employees | 3/20 | 0/4 | 2/3 | 1/13 |

#### 4.1.1. Ecosystem services

All informants (20) mentioned different kinds of functions, benefits and values that blue-green solutions give an urban area, such as recreation, biodiversity, stormwater detention, and water treatment as driving forces to work more with blue-green solutions. Several of the informants referred to the term ecosystem services and we have used this term to categorised all such functions, benefits and values from blue-green infrastructure. That ecosystem services provide values and qualities to the urban areas is seen as an important driver. The informants emphasised different ecosystem services as the most important;

> *The important thing is detention and treatment of stormwater. (Informant 7, 2016)*

> *Another incentive could be to create more biodiversity and the desire to create a different environment, not just a lawn but something else. That can be an important driver. (Informant 20, 2016)*

Cultural ecosystem services, like recreation and aesthetics, are also mentioned by the interviewees.

> *The need for recreation areas are the primary drivers behind the implementation. (Informant 10, 2016)*

> *Water gives a beautiful aspect to a city, combining park and water facilities (Informant 18, 2016).*

At the same time some of the respondents mentioned, that if there is a choice between biodiversity and construction of houses, nature comes second. The following quote gives an argument for why.

> *There are few who experience a visible damage when dragonflies decline in a river. (Informant 1, 2016)*

#### 4.1.2. Climate change

A majority of the interviewees (16) mentioned climate change as a driver to implement blue-green solutions. Climate change seems to be a driver at both a more local scale (the scare for inundation) and a larger scale (a societal challenge). The interviews show that there are awareness and knowledge about the changing climate and need to adapt urban areas to handle the increased precipitation. The torrential rain in Malmö 2014, resulting in major economic consequences for many actors: municipalities, private individuals, property owners and insurance companies, increased the focus on climate change.

> *Climate change is almost a positive thing and the fear of flooding. It has opened up for discussion with an entirely different width than earlier. (Informant 1, 2016)*

#### 4.1.3. Economy

Many of the respondents (7) mentioned that the financial aspect is a driver to implement blue-green solutions. There is an awareness of the economic impacts of flooding that may affect the municipality. One respondent argued that;

> *There is a fear of the economic impact of downpours, such as basement flooding, damages, compensation for poor planning (Informant 1, 2016).*

It was also argued that it is expensive to increase the number and dimensions of existing sewage pipes in the existing built environment. It was also argued that many pipes are getting old and will need to be replaced.

> *It is not economically viable to lay pipes in the existing built environment (Informant 10, 19, 2016).*

*If one is to follow up on the grid with larger pipes it will be expensive (Informant 3, 2016).*

Informant 1 argue that there is a difficulty working with nature, as it doesn't have a defined cost. This shows that natural values are therefore complex to include in city planning, but it may act as a driver that puts a tension on the existing stormwater regime.

#### 4.1.4. Politics of urban densification

Urban densification was mentioned both as a potential driver and a barrier in the interviews. There were 7 informants that mention urban densification as a potential driver to implement blue-green solutions. Most of them is working with planning (5).

*We know that we make more and more impervious surfaces, and then we have more water to take care of. It is the main driving force. (Informant 7, 2016).*

*I believe that the awareness grows continuously, especially in the work with urban densification. We need to address these questions. (Informant 6, 2016).*

This indicates that there is an awareness about how densification affects urban runoff. However, no 'blue' interviewees mentioned this as a driver.

#### 4.1.5. Knowledge of new municipal employees

Another driver mentioned in the interviews is how new employees have different knowledge and different points of view. 3 interviewers mentioned this as a driver.

*It feels like there is a new generation of officials on their way, so it feels like a lot has happened and blue-green solutions is a part of the work. If you think climate proof buildings. There is an increased awareness. It is clear that some senior officials continue as they have always done and then it is difficult to change later. (Informant 18, 2016)*

### 4.2. Barriers for blue-green solutions

Eight types of barriers to wide-spread implementation of new stormwater solutions were identified in the interviews. In Table 3, these barriers are presented in relation to how many of the informants that mentioned each barrier. In the following sections, the barriers are discussed, with slightly more focus on the most important barriers (according to the interviewees).

**Table 3**
Barriers against increased implementation of blue-green solutions identified among the informants. The categories are a categorisation where *blue* is officials working mainly with water, *green* is officials working mainly with ecology and vegetation and *planning* is officials working mainly with urban planning or architecture.

| Barrier | Number of informants mentioning it | Green | Blue | Planning |
|---|---|---|---|---|
| Economy | 18/20 | 4/4 | 3/3 | 11/13 |
| Lack of knowledge | 17/20 | 4/4 | 2/3 | 11/13 |
| Roles and responsibilities | 16/20 | 4/4 | 2/3 | 10/13 |
| Legislation | 16/20 | 4/4 | 3/3 | 9/13 |
| Municipal organisation | 13/20 | 4/4 | 1/3 | 8/13 |
| Urban densification and housing shortage | 10/20 | 2/4 | 1/3 | 7/13 |
| Political interests | 9/20 | 3/4 | 1/3 | 5/13 |
| Time and workload | 8/20 | 1/4 | 2/3 | 5/13 |

#### 4.2.1. Economy

The interviews conceived economy both as a barrier and as a driver, depending on which economical aspect the informants referred to. While only 7 informants mentioned economy as a driver, almost all (18) mentioned economy as a barrier to more blue-green solutions.

A majority of the respondents argued that economy is an important factor, defining the outcome of the planning process. Different municipal departments have their own budgets and their different responsibilities in the planning process in the municipality. This leads to a risk of 'silo' thinking, where a department only focus on the specific tasks and budget that has been allocated to it, missing a holistic view of the planning process. Sometimes the budget has too little flexibility to ensure a holistic view. Several informants argued that there is a difference between planning for a solution and a different story to implement them.

*Many times, these solutions exist at the planning stage. Space is allocated in the first sketches that the landscape engineers develop. The more time that passes, the more space the developer wants to exploit. The land is precious today and these solutions are excluded. (Informant 18, 2016)*

Furthermore, according to the interviewees there is an uncertainty concerning which actor that should finance and maintain blue-green solutions, creating a resistance to implement them.

#### 4.2.1. Lack of knowledge

Almost all of the respondents (17) mentioned that there is a lack of knowledge among officials regarding blue-green solutions. The comments show that lack of knowledge creates an inertia to understand the importance of blue-green solutions in the urban landscape. As a consequence, actors slow down or even block a change.

*There is need to work wider and to include the ecological expertise in a different way than we did before. Even more intersectoral and more ecological knowledge, either through the recruitment of new people or through educating those already working (Informant 11, 2016)*

The lack of knowledge does not only concern implementation of new solutions but also how solutions should be maintained. In several interviews lack of knowledge also include maintenance, and it is argued that even if construction costs are known, the maintenance costs are not. It is also argued that the lack of knowledge also concerns other actors, like private property owners.

*There is a very difficult actor and that is the property owner who has a rather big responsibility too. All villa carpets that are paved. There is no awareness, or at least very few are aware. (Informant 12, 2016)*

#### 4.2.2. Roles and responsibilities

In the studied municipalities, different actors involved in stormwater management chain have different skills, knowledge and training, from the strategic and overall planning, to detail planning for building permits, private property owners, and individual households. In the interviews the lack of clarity of roles and responsibilities emerged as an issue (16).

*It may also be that there is an unclear division of responsibilities or that we are not enough involved in each other's projects. (Informant 3, 2016)*

The interviews revealed a mixed picture regarding who has the overall responsibility for the implementation and management of blue-green solutions. Several interviews mentioned that the Department of Housing and Urban Development has the overall responsibility to establish blue-green solutions. It is also mention in the interviews that the water utility companies have an important role to play. But several

informants also argued that there should be a shared responsibility to implement blue-green solutions, involving not only the municipality but also consultants, property owners, and developers. It was argued that the latter actors do not realise their role in the big picture which increase the unclarity of responsibilities.

*The responsibility for the stormwater lies with everyone actually, right down to the house owner, but we are far from there. (Informant 16, 2016).*

#### 4.2.3. Legislation

It was highlighted in interviews (16) that the current legislation leads to an inefficient planning process to implement blue-green solutions. Municipalities cannot demand special, technical requirements for different landowners as was possible in Sweden before 2015. This means that municipalities cannot require more than stated in the PBL or Building Regulations BBR (SFS 2014:900).

*In the legislation it's possible to indicate a request but it is not possible to demand technical requirements. Land allocation is given through an exploitation agreement. The Environmental Code and PBL are in coalition with each other. There is a conflict between environment and permission to build. The motivation is there, but you are restrained. (Informant 17, 2016)*

The lack of special, technical requirements can therefore be a blocking barrier for experimentation and innovation to be established in stormwater regime. The municipality cannot make stronger demands on developers, which could have been a stimulating act for a change to occur. According to the interviews, the problem is that the detailed planning is mainly focused on exploitation which slows down any transition.

Several of the informants mentioned that it is a problem that blue-green solutions do not have a quantitative value in the planning process. There are clear standards about the number of parking spaces, the size of a turning zone or the number of schools, but there are no clear standards related to the size and number of blue-green space. This means that after demands for parking lots and schools are met, there is a risk that there is no physical space left for implementing blue-green solutions (Informant 15, 10, 2016). Another respondent argues in a similar manner;

*If you let all functions add on top of each other, the distance between houses and people become even bigger. Then we do not talk about the dense city, but the sparse, and then transport need are increased. We need to dare to prioritise. It is not possible to add functions on top of each other. Let's say that you must have six meters roadway, four-meter trees, and then you add on three-meter bike road and two-meter pavement. If you add all these measures on top of each other, the street canyons become very wide. (Informant 14, 2016)*

#### 4.2.4. Municipal organisation

In several of the interviews (13) it was argued that there is a lack of structure that can promote the cooperation needed to implement blue-green solutions.

*The structure, how the organisation is structured. It is this pipe thinking. You sit on your budget, your own resources, interests, responsibilities… Everyone talks about communication and collaboration. Everyone talks about it and then we use all the old tools and it's not working. (Informant 15, 2016)*

According to the interviews, involved authorities have their defined roles. There are various processes as well as pilot projects "owned" by the Planning respectively the Environment Department. But these innovative experiments and pilot projects have had difficulties to establish themselves as a mainstream solution as the ideas are not spread to other departments.

*We have made us famous with pilot projects here in town with Bo01 and Augustenborg and in this way we have actually gone from words to action quite fast. But to make this a work procedure and general thinking – there we not yet are and that has been much slower. This is due to that urban planning is such a broad and complex question and many issues should be handled in parallel (Informant 9, 2016).*

The interviews also showed that there is a willingness to cooperate, but there are barriers linked to how the municipality is organised.

*The structure of the municipality leads to a "narrow-thinking" because each department has their own budget, interest and responsibilities when it comes to community planning (Informant 16, 2016).*

#### 4.2.5. Urban densification and housing shortage

Half of the informants (10) mentioned densification and housing shortage as a barrier. Several informants said that there is a 'housing shortage panic' in the municipalities (Informant 9, 12, 15, 17, 2016), reflecting the political decision made in Sweden to construct a lot of new housing. One of the respondents argue that this 'housing shortage panic' lead to a risk that officials don't have time to take blue-green solutions into consideration (Informant 12, 2016). Indicating that the housing shortage discussion creates a stressing situation. But there is an awareness of this potential conflict between densification and blue-green solutions;

*It was great that we recognised that there was a conflict between dense and green (Informant 15, 2016)*

Another respondent argues that it is a focus on building houses;

*I think everyone is quite aware of this and now when we have the new population forecast, that Malmö is going to grow even more. We have to build a lot more houses, schools and kindergartens. So now there is a great focus on developing homes. This is the main priority. (Informant 9, 2016)*

Several of the informants are aware of the struggle between a need of more housing and the implementation of blue-green solution. But the more stressed short-term need of more houses, schools and kindergartens is more pressing than a more long-term need to handle a changing climate. The housing shortage affect people in a more direct way, making it hard for municipal officials to argue for the economic uncertainties to maintaining cost and the space that is needed for the blue-green solutions.

#### 4.2.6. Political interest

Several informants (9) mentioned that the urgent housing need is a priority for the politicians.

*Visions are hard to say no to. It is clear that we want multi-functional solutions and purify water, of course we want to save biodiversity. It's not hard. But it is when the individual decisions come in, not to make the connection between real estates and environmental goals. There is a will, but then it is the same politicians who approve urban densification and the constructions. (Informant 1, 2016).*

The balancing between the interests for high biodiversity and space for water on the one hand and for real estate development on the other hand influence the political agenda of stormwater management. Politicians can obstruct and partially block an increased implementation of blue-green solutions as the politicians have the last word when it comes to what can be built and not.

#### 4.2.7. Time and workload

Several of the informants (8) mentioned time and workload as a barrier that hinders the implementation of blue-green solutions.

> *All municipal administrations are committed to an "open" stormwater management, then how hard the issue is driven depends on how many other demands there are. (Informant 10, 2016)*

This may indicate that green solutions is a secondary issue and only dealt with if there are no other issues that are perceived as more pressing. Which mean that if there is time blue-green solutions can be dealt with. Other respondents clearly state that inclusion of blue-green solutions is a matter of time and workload.

> *In those cases, where more has not been done to integrate multifunctionality, is due to lack of time in the projects and that the workload is high for many (Informant 7, 2016)*

There are difficulties and complex issues in all projects, and there are many aspects that needs to be addressed. There are also many actors with different agendas. When there is a tight timeframe for a project, it is easier for officials to use the pipe-bound solutions (Informant 19).

## 5. Discussion

In this section we first discuss the identified drivers and barriers in relation to current literature and thereafter suggest solutions to overcome them inspired by the transition approach.

### 5.1. Drivers

Five drivers of change were identified in this study: ecosystem services, climate change, economy, politics of urban densification, and changing knowledge of new municipal employees.

The concern for ecosystem services and climate change is partly external to the stormwater regime and have their origin in international and national politics which some if the interviewees also referred to. The national debates surrounding topics climate change and the role of ecosystem services seems to have a general impact on the awareness among the interviewees, but there is also a more locally induced factors. The effects of recent, severe floods act directly on the current regime, creating a fear of more extreme events. Previous research has shown that it often takes a crisis for a transition to take place (Loorbach, 2007:18, Brown and Keath, 2008; Ashley et al., 2011). The importance of improved ecosystem services such as aesthetics, biodiversity and water retention capacities of green space are also identified in the literature as a driver for change (Widarsson, 2007; Ashley et al., 2011).

Increased costs of pipe-bound solutions was identified as an economic driver. Blue-green solutions were perceived as potentially more cost effective among the interviewees, which also has been identified in other studies from Sweden and England (Widarsson, 2007; Ashley et al., 2011). In the scientific literature there is also an increased focus on cost-benefit assessments of ecosystem services from blue-green solutions (Read et al., 2016; Ossa-Moreno et al., 2017). The national politics for densification of urban areas also emerged as a driver, in particular in combination with the cost efficiency argument and the need for climate adaptation. The inclusion of blue-green solutions is seen as more feasible than re-piping a whole city. This has also been identified in other studies, including the reduction of costs for replacing pipes, water treatment, and landscape maintenance (Foster et al., 2011, American Rivers, 2008; Brears, 2018).

Another identified driver for change is the knowledge and perspective on urban planning that new employees can bringing from their recently finished university educations. This may introduce new perspectives and ways of collaboration which may increase the focus on blue-green solutions. In combination with practical knowledge of how to implement these solutions, local uptake and further innovation might facilitate a more widespread implementation, according to the interviewees.

In the literature, other drivers are mentioned that were not identified in this study, like technical problems related to flooding that stress the regime and initiate use of blue-green solutions (Widarsson, 2007; Ashley et al., 2011, Sörensen & Emilsson n.d.). Another factor not mentioned in the interviewees is the critical need to reduce the amount of extraneous water to waste water treatment plants and in some cities existing drainage system has reached its maximum capacity and cannot handle more stormwater, when new or existing areas are developed (Widarsson, 2007; Sjöman and Gill, 2014). The reason why we did not identified this barrier in this study may be due to the selection of interviewees. Even though there were interviewees with water management competence none of them were responsible for water treatment plants.

Drivers to induce a socio-technical transition from pipe-bound to blue-green stormwater management, as identified in this study, have according to de Haan and Rotmans (2011) been categorised in three categories: stress, pressure and tensions. *Stress* emerges when the regime is inadequate or internally inconsistent in meeting the needs of the system. In this study, three such stresses were identified: the economic driver of improving cost efficiently and the lack of capacity in existing sewers when urban areas are densified, which was mentioned by several, and technical problems, which was identified through the literature. Ecosystem services, or rather the lack of ecosystem services in the current regime, might also be categorised as a stress. However, these stresses are less strong than the stress identified in other studies related to the incapacity of the sewage treatment system. In Västerås, Sweden, such a stress has led to cooperation over organisational borders and a new surface water strategy was written with the goal to eliminate the combined system, reduce extraneous water to the waste water treatment plant and to reduce pollution of Lake Mälaren (Widarsson, 2007). *Pressure* typically comes from alternative technologies that become viable competitors to the regime. In the interviews, it was mentioned that the knowledge new employees bring in might give such a pressure on the regime. Several also mentioned that different pilot projects and newly built areas, serving as flagships for transformation, might have a similar effect. Both municipalities in the study are well-known for such projects, but these have still not led to general implementation of blue-green solution in the planning process. *Tension* is when the system compromises in its relation to its natural or social environment. In this study, ecosystem services, climate change and politics of urban densification are categorised as such tensions. They all relate to the system outside the regime and put pressure for change of the regime.

### 5.2. Barriers

The identified barriers include economy, lack of knowledge, roles and responsibilities, legislation, municipal organisation, urban densification and housing shortage, political interest, and time and workload. Several of these barriers are closely related.

The study indicates that economic argument, lack of money, becomes an important barrier for the implementation of blue-green solutions. Due to lack of funding or funding models, public officials and project leaders choose the well-known way out: pipe-based solutions and sometimes externally financed pilot and flagships projects. From the interviews, it is clear that economy and lack of knowledge of the solutions efficiency and impact is closely interlinked and then the solution is perceived as more risky. This is also something that is confirmed in the literature. Penniman has argued that construction and maintenance costs and unclarities about who is supposed to pay and maintain are major arguments to continue with piped solutions (Penniman, 2013). It has also been argued that there is a lack of resources to work proactively with alternative solutions (Ashley et al., 2011), especially in many small municipalities (Widarsson, 2007),

which also seems to apply to our case cities. Widarsson argues further that the water utility office often is weak in comparison with office for the built environment. Cettner et al. (2014) have similar findings where economic arguments counteract an increased use of blue-green solutions, especially as developers perceive non-piped solutions as more costly (Ashley et al., 2011). However, in this case the interviewee saw solutions as potentially more cost efficient, but maybe as argued above, the lack of economic models to implement them and lack of knowledge about maintenance cost the implementation rate remains slow outside pilot and flagship projects.

The unclarity concerning who is supposed to pay and maintain is closely linked to several other barriers, like unclear roles and responsibilities, legal structures and municipal organisation. According to the interviews, municipal water management is perceived as compartmentalised. The separation of expertise has also been recognised in other studies (van der Brugge et al., 2005; Mguni et al., 2015; van Herk et al., 2011b, Qiao et al., 2018), where water management is described as a wicked problem, influencing the possibility to divide responsibility in a clear manner. The wickedness of water management has been recognised and increasingly dealt with at the watershed scale level in rural areas (Pahl-Wostl, 2015), but a watershed approach has not yet been implemented in cities, which is a bit remarkable as both the European Water Framework and the Floods Directives covers cities. In this study, the identified unclarity in relation to stormwater management is mainly related to the unclear legal responsibilities of private land owners versus the municipality in relation to adverse effects of downpours. This unclarity has also been recognised earlier (Ashley et al., 2011; Persson et al., 2012; Dir, 2015:115, SOU, 2017:42). According to the interviews, one of the major legal barriers is the lack of possibilities to pose special, technical requirements on urban developers and property owners. Legal barriers have been mentioned in several studies, but have not been a major issue of concern, which is a bit surprising considering that the law set the rules of the games and who is responsible for what and when. This could be due to an increased focus on urban governance studies where the focus lies on other societal structures and relations (e.g. a changing relation between the state and the market) than role of the rule of law, (e.g. restriction of arbitrary exercise of power by subordinating it to well-defined and established laws).

The political agenda for urban densification plays an important role as a barrier for the interviewees. The lack of housing in Sweden has a large political focus, which makes it difficult for officials to argue for blue-green solutions if they are to compete with space for housing. In Scania, 28 of 33 municipalities has a housing shortage, and at the national level only one municipality has an excess of housing (County Administrative Board Scania, 2017). However, in a dense city, the problem is not only a lack of capacity of stormwater pipes, but also the potential adverse effects of lack of green space for urban dwellers (Tratalos et al., 2007; van de Meene et al., 2011; Ashley et al., 2011). Among the interviewees, there is an awareness of the conflict between denser cities and available amount of green space and there is a worry that constructors' interests are prioritised over the public need of green space. Private actors affect land use through investments and the urban infrastructure is largely influenced by their economic and social interests. Focus on private exploiters desire to maximise profits as earlier been identified as a factor that can both block and allow for a change (Olazabal and Pascual, 2012). Similar findings have also been identified in other studies where constructors interest influence municipalities to opt for traditional stormwater management to maximise land exploitation (Hordijk et al., 2014). According to Cettner et al. (2013), the urban planners have therefore a key role in creating links between the public planning process and other actors, which also link up to their role in relation to the use of environmental law to protect the wellbeing of urban inhabitants and nature.

In Sweden, there is a widespread awareness about blue-green solutions (Ashley et al., 2011). Nevertheless, the interviews revealed a lack of knowledge of how to construct and maintain these solutions which was briefly mentioned above. Several blue-green solutions have been implemented in the case cities through pilot projects driven by smaller groups of engaged persons and funded by external project money. The interviews indicate that the knowledge gained in these projects have not been mainstreamed into the general stormwater management practice in the two municipalities. Similar findings have been found in other studies, where the introduction of blue-green solutions and climate change adaptation measures have been dependent on single, engaged persons within the municipal organisation (Storbjörk, 2010; Widarsson, 2007; Cettner et al., 2014). It is also argued that there still is a lack of knowledge regarding cost-efficiency and lack of practical experience from the effects and impacts of new solutions (Widarsson, 2007; Ashley et al., 2011). From the perspective of this study, the situation seems to fundamentally be a question of organisation and there seems to lack structure to institutionalise the knowledge transfer from projects that have implemented blue-green solutions. This lack of continuity and vulnerable knowledge base was actually identified years ago by Storbjörk (2010). Another reason may be that these project, as identified earlier, are financed by external money and not as a part of the ordinary municipal work.

The interviewees also argued that barriers are due to lack of time and a heavy workload. Yet others argued that the problem is lack of willingness of public officials to try new solutions and a culture where they are not permitted to test and fail introducing blue-green solutions as a part of a learning process, something also identified by Farrelly and Brown (2011). Some interviewees related the lack of implemented blue-green solutions to a lack of political interest. This has also been recognised in other studies, where it has been argued that when urban flooding is high on the agenda, hard solutions may be prioritised and the benefits blue-green solutions are down played (Ashley et al., 2011). According to this argument, the 2014 downpour in Malmö may be one reason to why the implementation of blue-green solutions is slower than expected based on the well-known pilot examples from Augustenborg and Västra Hamnen.

These findings are similar to the findings of a literature review by Qiao et al. analysing 44 peer-reviewed papers (Qiao et al., 2018). They conclude that governance factors are the main reason for the slow pace of implementation of urban sustainable stormwater management. Unclear leadership and responsibilities, lack of funding, lack of cost data on sustainable stormwater management solutions, lack of space and knowledge, lack of uniform guidelines, and lack of stakeholder participation were found to be the most prominent reasons (Qiao et al., 2018).

### 5.3. Suggestions

Time is short when aiming to manage adverse effects of urbanisation and climate change. Blue-green solutions may handle some of these challenges through an increase or improvement of the green spaces for the benefit of both humans and wildlife (Cettner et al., 2014; Voskamp and van de Ven, 2015). Under this time pressure, and in the midst of a densification boom of Swedish urban areas, there is an increased need to identify the factors causing the lack of transition to the use of more blue-green solutions and find counter-measures to speed it up (Liu and Jensen, 2018). Based on the identified set of driving forces and barriers, this study indicates that societal change is a complex process. The fact that several barriers were mentioned by most of the interviewees, clearly show that a wide range of changes are needed to change the current stormwater management regime, which is one of the main finding in this study. There are multiple instances, connections, links, and levels that affect the outcome of a barrier or momentum to increase the implementation of blue-green solutions. We argue that a sustainability transition has to include the simultaneous improvement of several aspects of the inter-institutional and public-private collaboration.

In a transition context it is often pointed out that innovation of

conventional ways of designing and managing urban spaces and structures, and practical experiences of this approach through testing and improvement are essential for inducing change. It is also argued that through such a development, new social norms are developed concerning how to solve a problem (van der Brugge et al., 2005; de Haan and Rotmans, 2011; Ashley et al., 2011; Farrelly and Brown, 2011). One reason for the strong attention given to the role of niche innovation is, according to Cettner et al. (2014), that a bottom-up transition is more visual to media, and that it leads to an increased public awareness and hence political ears. According to this interpretation of change, a strong focus has so far been put on promoting different types of technical innovations through the channelling of money to the niche level. However, based on the findings in this article, this view on transition is built on a rather simplified view of the interaction between societal actors and legal structure, at least in a Swedish context. In the transition literature, there are voices arguing for the importance of influencing other factors at the landscape level (Koppenjan et al., 2012; Geels, 2011; Smith et al., 2005; Widarsson, 2007; Mguni et al., 2015; Brown and Keath, 2008), where for instance Brown and Keath (2008) have argued that drivers at the landscape level are required to stimulate change in the regime as innovations and new technical solutions introduced at the niche level are not enough. This is confirmed by the interviews in this study and is another of the main findings. Yet others have argued that to achieve a transition, changes must occur and be integrated between the levels (Geels and Schot, 2007). Based on our findings we argue for the latter understanding of the potentials of change, change is promoted by a combination of alternation at different scales of the system. Transition requires a mutually reinforcing shift related to cognitive, normative, and regulative aspects of a regime, as proposed by Scott (1995). Hence to make sure that the implementation of blue-green solutions in the case municipalities becomes more than pilot cases proper regulations, an appropriate municipal organisation and clear collaboration structures along the urban planning structure is central. It also seems important that involved actors find a common language to communicate with each other.

So, what can this study teach us about the potential ways to overcome the barriers, strengthen the drivers and to encourage transition to a more sustainable and multifunctional urban stormwater management in a southern Swedish perspective?

#### 5.3.1. Legal

Legislation is crucial for how municipalities will be able to implement blue-green solutions in the future as the rule of law decide the rules of the game which to several extent change with threats from climate change. One way to reduce the legal barrier is linked to the removal of the possibility to define specific, technical requirements. Early 2018, the Swedish government presented a national climate change strategy (Skr. 2017/18:238). The strategy is suggesting different measure to adapt the society to climate change. One possible measure is changes in the legislation, i.e. the PBL, and either reintroduce the possibilities to pose specific, technical requirement concerning water management capacity at each plot, or demand private actors to submit site improvement permit when changing the infiltration capacity of their land. The latter is actually suggested in a proposition that is up for decision at in the Swedish parliament later in 2018 (Prop. 2017/18:163). The political debate anticipating the removal of the special, technical requirements mainly targeted technical requirement concerning the house construction than issues relating to the management of public goods. However, the possibility of municipalities to protect cities from inundations and lack of green space was simultaneously reduced. If the suggested changes are implemented it may provide a very important basis for increased inclusion of blue-green solutions. According to Liu and Jensen (2018), green technology and innovations, such as blue-green solutions, cannot become mainstream until regulations exist to support their inclusion, which many of the informants in this study mentioned as a problematic area. Other research has also shown that demands from authorities and legislation that puts a pressure on the current regime are important for transition towards widespread implementation of alternative solutions (Widarsson, 2007; Ashley et al., 2011). In relation to this approach, it may be important to ensure that there are good planning documents indicating the gain and loss in general wellbeing based on different densification scenarios. In that sense moving the focus on blue-green solutions outside the construction plot.

A more radical way to induce change through legal means could be to demand that each parcel of land to handle a certain percentage of the rain water landing on it, for example by implementation of such a calculation in a detail plan and updated with our changing understanding of the impact on the urban climate. It is clear that this approach would be easier when building on new land, but in the already built areas and in relation to a densifying city it is much more difficult and will include several conflicts of interests. In line with these suggestions, Widarsson (2007) suggests using a model from Franklin, US, in Sweden. In Franklin, authorities demand a permit to discharge stormwater, which must be renewed every five years and can only be given if there is a stormwater programme with clear objectives, including routines for maintenance. The municipalities have, due to the planning monopoly in Sweden, a large potential to change the management of stormwater and create a more holistic approach to policy development and planning through dialog. However, today implementation of blue-green solutions is often left to a question of negotiation between constructing companies and the municipality.

As mentioned in the introduction, the EU legislation could potentially influence the regime of stormwater management. The two directives have interestingly not been mentioned by any of the interviewees and are seldom mentioned in professional seminars and conferences on stormwater management in Sweden. The EU Floods Directive was implemented as a decree and not as a law in Sweden, which might lead to an unclear role for the municipalities (Thorsteinsson and Larsson, 2012). As flooding from sewers may be excluded in the work with the EU Floods Directive (Directive, 2007/60/EC), it might be more fruitful to use the EU Water Framework Directive in the work with blue-green solutions. Through the EU Water Framework Directive, water has become more important for the municipalities, with stronger political interest, a longer time perspective and with the focus on water as a resource (Waernbaum, 2010). While there is an action programme, ensuring that all municipalities have to do their duty, great uncertainties still inhibit the municipalities from working effectively with the framework (Waernbaum, 2010).

#### 5.3.2. Economy

With the current regime, the economy of stormwater management is strongly related to the municipal organisation of it. The budget of the municipality follows the same ‘silos’ as the rest of the organisation. As a consequence, the possibilities and potential multiple benefits of combined blue-green solution is overlooked when each municipal department focus on “their task” management of water, green space, recreation, safety etc.

One way to strengthen the economic driver, might be to differentiate the water fee payed to the municipalities/water utility companies so that property owners with less impervious surfaces pay less (Widarsson, 2007). Similar incentives have been tested for decades, for instance you can get 2500 SEK (€ 240) per disconnected downpipe in Malmö (VA Syd 2018), but such a possibility needs to be developed into an economic model that can be used by more municipalities. In relation to this discussion it will be important to discuss and clarify what the water fee actually can include and be used for. Hence a redefinition of what a water fee could include as services should be developed.

Financial support to increase the number of wetlands and ponds could be introduced. In 2018 the Swedish government decided to distribute SEK 200 million (€ 19 million) per year under three to

municipalities to strengthen the landscapes capacity to store water. Some of this support may target urban areas and can potentially be a way both to store and handle water (Jansén, 2018).

Several of the interviewees mentioned that there is an uncertainty regarding the economy of blue-green solutions. Some of this uncertainty is probably related to the organisation of stormwater management and an unclear understanding of how to interpret the multifunctionality of such solutions, where several different departments and stakeholders gain from them (Read et al., 2016), while fewer actually pay for construction and maintenance. It is also important to monitor and evaluate constructed solutions systematically to gain new knowledge about design, construction, and maintenance, and their related economical questions, which is often not done today.

#### 5.3.3. Knowledge and learning processes

In the interviews a need to learn and test solutions at the niche level was raised. The importance of knowledge has been confirmed in other studies where it is forwarded that an increased knowledge among stakeholders can encourage the transformation and integration of different skills and approaches, open new ways of thinking as well as drive the uptake of new technologies in the urban context (McCormick et al., 2013). Pahl-Wostl argued already 2008 that to test new solutions the municipalities can create a solution-oriented document base, so a project manager can more easily find solutions which can lead to increased adaptive capacity (Pahl-Wostl et al., 2008). From this study it is clear that if such testing is just performed by using external project money, such as in Augustenborg in Malmö (Stahre, 2008), the solutions are not necessarily adopted by the regular management. To ensure that what is learnt from these projects and incorporate it into municipal everyday practices, stronger structure for organisational learning and knowledge transfer structures are needed, which is one of the main findings from this study. As noted by Geels (2011), if sufficient time is given to gain experience, develop knowledge and innovation, and update regulations, blue-green solutions could mature as an alternative approach to pipe-bound solutions to urban stormwater management. Mguni et al. (2015) argues that niche innovations have begun to mature, and that they have a much broader use than before. However, blue-green solutions are not the current standard in Sweden and most implemented solutions have been a part of different externally financed pilot projects.

It is clear that there is a need to increase the knowledge about blue-green solutions, but this is rather related to knowledge exchange and sharing between sectors, than lack of understanding of what a blue-green solutions are. In this context, the perceived more holistic understanding of the importance of blue-green solutions within the new generation of employees as identified in this study could positively influence the future implementation. A complementary solution could be to develop a catalogue of solutions (including general ideas of their benefits, implementation and maintenance cost) that different actors can use. Such a catalogue could also include information about other benefits of blue-green solutions than water management, and in that sense strengthening the knowledge of the potential multi-functionality of blue-green solutions. Based on previous conclusions it seems important that such a catalogue of solution is context specific, hence sharing good examples across Europe may be more contra productive especially when there is a general understanding of what blue-green solutions is the case is in Sweden. In Denmark, a course concept called Urban Water Platform, were local authorities sends 3–5 persons from at least different departments to learn from lectures and study visits and to work on idea development and communication for their own projects (Nielsen and Jensen, 2016). The course was given when blue-green solutions still were relatively new in Denmark, but a similar concept could still be fruitful to enhance knowledge exchange and sharing within and between local authorities. If the need of blue-green solutions could be clarified, it could become a way to make it easier for officials to prioritise implementation of more blue-green solutions. There is a tension between interests, values and prioritise (Storbjörk, 2010).

Widarsson (2007) suggests that house owners should be informed about flood risk when they buy the house through for example developing different type of climate adaptation labelling for houses. Such information is for example available in Denmark (Danish EPA, 2018). In one of the interviews, it was mentioned that an important step to induce a change would be to integrate property owners and the general public in the stormwater management. This could also reduce the boundaries between the blocks of private owned and public owned land and in the long-term lead to a more efficient establishment of blue-green solutions in the urban environment. VA SYD has also recently started to work more directly with private property owners, through the project “Together we make space for water” (VA SYD, 2018).

#### 5.3.4. Organisation of spatial planning

An organisational structure in the municipality that ensure cross sectoral learning process could be one way to overcome the sectoral divide and increase the speed of organisational learning. Municipalities could for example employ a person in the planning system that ties together the tasks, facilitates dialogues between involved actors and ensures a joint understanding of the problem at stake. In Wales, the surface water management strategies are linked to the green space strategy (Ashley et al., 2011), which probably is another a fruitful way to make the planning more holistic. It has been argued before that to succeed with implementation of blue-green solutions, involvement of different actors, with different backgrounds, is needed (van der Brugge et al., 2005; van de Meene and Brown, 2009; Mguni et al., 2015), but there is currently a lack of cooperative structures and methods. Widarsson (2007) suggest that groups are formed with representatives from all involved departments to increase cooperation within the municipal organisation. In relation to this suggestion, Holtz et al. (2008) argues that innovation needs to be integrated into existing cultural networks and structures. As the planning process include various municipal officials, it requires trans-disciplinary and trans-professional approaches and skills (van Herk et al., 2011a). Such skills or methods for collaboration has to be installed. Artmann et al. (2017) have developed an indicator based framework for such integration but as stated in their conclusion there is a need the integration of various sources of data. Based on the findings of this is something the interviews are aware of but it will take time. Hansen et al. (in press) argue in a similar manner that there is a need to reorganise and improve the data collection and management structures as well as collaboration and municipal learning structures to facilitate the planning of multifunctional green infrastructure of green cities. This is also in line with the argument concerning the need of good planning documents indicating the gain and loss in general wellbeing based on different densification scenarios mentioned above. Storbjörk (2010) investigated barriers for organisational learning in two Swedish municipalities. In one of the municipalities, the city council waits for national regulation of climate change adaptation, in this case flooding risk reduction, before they act. The other municipality engage neighbouring municipalities, arrange conferences, etc. While this is a more proactive approach, much of the work is done by a single servant and therefore vulnerable. It is therefore also important that every city has a surface water management strategy with clear goals (Widarsson, 2007), like the climate adaptation plans in Denmark (Københavns Kommune 2011) or the surface water management strategy from Welsh Water (Ashley et al., 2011), where they clarify what to do and why. Co-learning projects and exchange between municipalities also seems to be a possible way forward. In the south of Sweden there is a network called the Climate municipalities, working cooperatively with politics, networking, and knowledge transfer. Such networks could be used as a base for knowledge exchange.

Another measure that supports the organisational capacity could be to increase dialogues and to strengthen capacity building among public and private landowners about the potential benefits of introducing blue-green solutions. A recent study, making a cross-case comparison of communal urban gardens (CGUs) comes to a similar conclusion, that

moving beyond a top-down control, and managed with a sensitivity to local dynamics and context can increase the impact can increase the impact of CGUs as a nature-based solutions (van der Jagt, 2017). This capacity building could increase the understanding and develop the benefits (for example recreation, lower temperature, noise reduction, health benefits) of blue-green solutions in cities in a similar way as integrated water management does in rural areas (Halbe et al., 2018).

In Copenhagen, public dialogues have been initiated to locally verify and legitimise stormwater solutions for flood control. This type of initiative can create a consensus among actors and they can find common approaches to mainstreaming of blue-green solutions. It is also important that public and private landowners, officials, consultants and politicians find common approaches to achieve an integrated flood-proof stormwater management.

Liu and Jensen (2018) argues that transition is two-folded. Innovative projects and experience from them create a deeper knowledge among actors, but more structural changes are also needed such as changed regulations for new solutions to mature. There is a need to combine top-down legal changes and strategies, and bottom-up niche projects that promote learning processes, to accelerate the transformation process from pipe-based solutions to nature-based solutions. This need for a two-folded transition pathway is also clear from this study, which is, as mentioned before, one of the main findings. Niche projects have a difficult to establish them self as a part of the planning culture in the municipality. The many innovative pilot projects in Malmö and in Helsingborg indicates that municipal actors are able operate at niche level, as they support, invest in and seek funding to start up pilot projects. However, there seems to be a missing link between these niche level projects and the main planning culture, as the ideas and knowledge have not been mainstreamed into the municipalities more daily practice. Clear responsibilities among regime institutions, favourable conditions provided for developing accountability, collective responsibility, and improved incentives as well as clear procurement rules, and municipal decision-making processes for public-private collaboration, may help to overcome this (Cettner et al., 2014; Cettner et al., 2013; Kennedy, 2011; Lund and Vaaben, 2014).

### 5.4. Conclusions

In this study, five drivers and eight barriers for transition to widespread implementation of blue-green solutions in urban planning has been identified through interview with twenty municipal officials. The drivers mentioned by most of the interviewees were benefits from ecosystem services and climate change, but also economic factors and politics of urban densification were mentioned by almost half of them. As the barriers are stronger, few solutions are currently implemented, except for externally financed projects (mainly EU funding). The introduction of blue-green solutions cannot be an issue of whether a municipality will be able to attract EU money or not.

Several of the barriers were mentioned by more than half of the interviewees, indicating that the solution to the barriers is a complex issue with a need for multiple, parallel strategies, which is one of the main findings from this study. A vast majority of the interviewees mentioned economic challenges, unclear roles and responsibilities and lack of knowledge as important barriers. About three fourths of the interviewees mentioned non-supportive legislation and municipal organisation as barriers and about half of them mentioned urban densification and housing shortage, lack of political interest and lack of time and heavy workload as other barriers. The study shows, not surprisingly, that socio-technical transition is a complex process with closely interconnected barriers and drivers. Often niche innovations, where learning can occur, are put forward as an important driver for change, but another of the main findings from this study is that this is a too simplified view. Potential ways to overcome the barriers and to encourage transition were discussed. These include changes in the legal and economic structure of stormwater management, ways to increase knowledge and improve the learning process, nurturing a culture of experimentation, and suggestions for changes in the organisation of spatial planning to achieve a socio-technical transition of urban stormwater management. The change and or clarification of the rule of law in relation to water management in a climate change perspective seems to be central.

In the end, handling water need to take space in the urban matrix. But, as one of the main findings from this study shows, for the success of their inclusion, knowledge seems to be crucial and educational efforts are important at different levels in the planning, building and maintenance process of blue-green solutions. This is a slow process which has to involve the whole planning process. It is therefore important that employees have a good general knowledge of both ‘blue’ and ‘green’ issues as well as having contacts and networks in the different sectors of the municipality. It is also essential that municipal employees have a good understanding of their role in promoting urban wellbeing for both human and nature. More space efficient and multifunctional solutions could be introduced, especially if planners learn more about the different qualities that a blue-green solution could have. However, there is a limit to how little space these solutions can use to become meaningful. Like there today are standards for the number of parking spaces or the turning radius of a turning zone, similar standards could be included in the urban planning for urban green and stormwater management with blue-green solutions. This could increase the attention given to these solutions. It is obvious that higher priority of blue-green solutions is important for its widespread implementation.

A total regime shift in stormwater management, where all pipes are retrofitted with blue-green solutions, is probably not possible or even desirable if we are going to live in dense cities, but the idea of blue-green solutions must influence all reconstruction and all new developments in the urban space, also considering and reflecting on the totality of paved, impervious areas which definitively must include interactions with traffic planning to ensure the utilisation of all potentials for blue-green solutions.

## Declarations of interest

None.

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